PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-149951

(43)Date of publication of application : 02.06.1998

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(51)Int.Cl. H01G 5/18

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(54) VARIABLE CAPACITANCE CAPACITOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a variable capacitance capacitor, the capacitance change of which can be controlled with high accuracy.

SOLUTION: Leg sections 2a and 2b are formed on a substrate 1 at an interval, and beam sections 4a and 4b are respectively extended from the sections 2a and 2b and connected to a common moving piece 5. The sections 4a and 4b and piece 5 are oppositely faced to the substrate 1 with gaps 10 in between, and reference substrates 8 are formed on the surfaces of the sections 4a and 4b and piece 5 facing the substrate 1. Then, drive electrodes 6a and 6b respectively faced to the sections 4a and 4b and a detecting electrode 7 faced to the piece 5 are formed on the substrate 1. The widths D of the beams of the sections 4a and 4b become narrower toward the piece 5 from their base end sections. When the sections 4a and 4b are deformed by bending the sections 4a and 4b toward the substrate 1, the interval between the reference electrode on the piece 5 and the detecting electrode 7 changes, and the change of the capacitance between the electrodes 7 and 8 can be controlled with accuracy.

LEGAL STATUS [Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] A substrate and two or more legs which fixed formation is carried out and are arranged by this substrate through a gap, The beam section by which expanding formation is carried out from each [these] leg, and opposite arrangement is carried out through said substrate and gap, The movable piece by which is connected common to the tip side of each [these] ****, and opposite arrangement is carried out through said substrate and gap, The movable electrode formed in the substrate opposed face of this movable piece, and the substrate opposed face of said ****, It is the variable-capacity capacitor which has the fixed electrode by which is formed in said substrate and opposite arrangement is carried out through said movable electrode and gap, and is characterized by said **** considering as the configuration in which the width of face of the beam by the side of a tip is narrowly formed rather than the end face side.

[Claim 2] It is the variable-capacity capacitor according to claim 1 which separation formation of the fixed electrode is carried out at the movable piece counterelectrode which counters the substrate opposed face of a movable piece, and the **** counterelectrode which counters the substrate opposed face of the beam section, accomplishes the above-mentioned movable piece counterelectrode with the detection electrode for detecting the electrostatic capacity between movable electrodes, and is characterized by to consider the above-mentioned **** counterelectrode as the drive electrode for bending and making the beam section transform, and the accomplished configuration.

[Claim 3] It is the variable-capacity capacitor according to claim 1 or 2 which separation formation of the movable electrode is carried out at the movable electrode formed in the substrate opposed face of a movable piece, and the movable electrode formed in the substrate opposed face of the beam section, accomplishes the movable electrode of the above-mentioned movable piece with the reference electrode for the detection for detecting the electrostatic capacity between fixed electrodes, and is characterized by to consider the movable electrode of said **** as the reference electrode for the drive for bending and making the beam section transform, and the accomplished configuration.

[Claim 4] A substrate and two or more legs which fixed formation is carried out and are arranged by this substrate through a gap, The beam section by which expanding formation is carried out from each [these] leg, and opposite arrangement is carried out through said substrate and gap, The movable piece by which is connected common to the tip side of each [these] ****, and opposite arrangement is carried out through said substrate and gap, The movable electrode formed in the substrate opposed face of this

movable piece, and the substrate opposed face of said ****, It is the variable-capacity capacitor characterized by considering as the configuration which has the fixed electrode by which is formed in said substrate and opposite arrangement is carried out through said movable electrode and gap, juts out said movable piece rather than the width of face by the side of the tip of the beam section, and is formed in the broad side.

[Claim 5] The beam section is a variable-capacity capacitor according to claim 4 by which width of face of the beam by the side of a tip is characterized by considering as the configuration currently formed narrowly rather than a end face side.

[Claim 6] It is the variable-capacity capacitor according to claim 4 or 5 which separation formation of the fixed electrode is carried out at the movable piece counterelectrode which counters the substrate opposed face of a movable piece, and the **** counterelectrode which counters the substrate opposed face of the beam section, accomplishes the above-mentioned movable piece counterelectrode with the detection electrode for detecting the electrostatic capacity between movable electrodes, and is characterized by to consider the above-mentioned **** counterelectrode as the drive electrode for bending and making the beam section transform, and the accomplished configuration.

[Claim 7] It is the variable-capacity capacitor according to claim 4, 5, or 6 which separation formation of the movable electrode is carried out at the movable electrode formed in the substrate opposed face of a movable piece, and the movable electrode formed in the substrate opposed face of the beam section, accomplishes the movable electrode of the above-mentioned movable piece with the reference electrode for the detection for detecting the electrostatic capacity between fixed electrodes, and is characterized by to consider the movable electrode of said **** as the reference electrode for the drive for bending and making the beam section transform, and the accomplished configuration.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the variable-capacity capacitor which can carry out adjustable [of the electrostatic capacity].

[0002]

[Description of the Prior Art] A variable condenser and varactor diode are known as a variable-capacity capacitor. The above-mentioned variable condenser has the electrode which counters mutually as everyone knows, and rotation devices, such as a motor, carries out adjustable [of the opposed face product of the electrode which counters mutually according to the above-mentioned rotation device], and carries out adjustable [of the electrostatic capacity inter-electrode / these]. Moreover, the above-mentioned varactor diode can carry out adjustable [of the parasitic capacitance] with the magnitude of the electrical potential difference impressed from the outside.

[0003] If it is included in an oscillator circuit, a modulation circuit, etc., for example, a high frequency signal is added, such a variable-capacity capacitor outputs the output voltage signal according to the magnitude of the electrostatic capacity of the variable-capacity capacitor, and it will be used, carrying out an adjustable setup of the electrostatic capacity (parasitic capacitance) of the variable-capacity capacitor so that the above-mentioned oscillator circuit, a modulation circuit, etc. incorporating a variable-capacity capacitor can obtain a desired circuit output.

[0004]

[Problem(s) to be Solved by the Invention] However, since the rotation device in which said variable condenser has complicated structure and it is indispensable to carry out adjustable [of the electrostatic capacity] is difficult to miniaturize, it has the problem that it is difficult to attain the miniaturization of a variable condenser.

[0005] Moreover, although said varactor diode is easy to miniaturize since it can be formed with a single component, in order to raise pressure-proofing, internal resistance r must be enlarged, and the following problems arise according to increase of this internal resistance r.

[0006] The Q value of the output voltage signal of the above-mentioned varactor diode can be shown in a degree type (1).

[0007] Q= 1/(2pifcr) ..... (1)

[0008] However, f shown in an upper type (1) is the frequency of the high frequency signal added to varactor diode, c shows the parasitic capacitance of varactor diode and r shows the internal resistance of varactor diode.

[0009] If internal resistance r is enlarged in order to raise pressure-proofing of varactor diode like the above, as shown in an upper type (1), Q value will fall sharply. For this reason, the carrier noise of an output voltage signal will become large, and will worsen the SN ratio of an output voltage signal. Thus, if internal resistance r is enlarged in order to raise pressure-proofing of varactor diode, the problem that the output engine performance of varactor diode gets worse will arise.

[0010] It is made in order that this invention may solve the above-mentioned technical problem, and the purpose is easy to miniaturize, it is possible to perform adjustable control of electrostatic capacity with a sufficient precision, and it is in offering the variable-capacity capacitor which can moreover aim at improvement in the Q value of an output voltage signal, and can raise the output engine performance of a variable-capacity capacitor.

[0011]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is taken as a means to solve said technical problem with the following configurations. Namely, two or more legs which fixed formation of the 1st invention is carried out at a substrate and this substrate, and are arranged through a gap, The beam section by which expanding formation is carried out from each [these] leg, and opposite arrangement is carried out through said substrate and gap, The movable piece by which is connected common to the tip side of each [these] ****, and opposite arrangement is carried out through said substrate and gap, The movable electrode formed in the substrate opposed face of this movable piece, and the substrate opposed face of said ****, It has the fixed electrode by which is formed in said substrate and opposite arrangement is carried out through said movable electrode and gap, and said **** is taken as a means to solve said technical problem with the configuration in which the width of face of the beam by the side of a tip is formed narrowly rather than a end face side.

[0012] The movable piece counterelectrode with which the fixed electrode with which the 2nd invention constitutes the 1st above-mentioned invention counters the substrate opposed face of a movable piece, Separation formation is carried out at the ****

counterelectrode which counters the substrate opposed face of the beam section, and the above-mentioned movable piece counterelectrode is accomplished with the detection electrode for detecting the electrostatic capacity between movable electrodes. The above-mentioned **** counterelectrode is made into a means to solve said technical problem with the drive electrode for bending and making the beam section transform, and the accomplished configuration.

[0013] The movable electrode with which the movable electrode with which the 3rd invention constitutes the 1st or 2nd above-mentioned invention is formed in the substrate opposed face of a movable piece, Separation formation is carried out at the movable electrode formed in the substrate opposed face of the beam section, and the movable electrode of the above-mentioned movable piece is accomplished with the reference electrode for the detection for detecting the electrostatic capacity between fixed electrodes. The movable electrode of said **** is made into a means to solve said technical problem with the reference electrode for the drive for bending and making the beam section transform, and the accomplished configuration.

[0014] Two or more legs which fixed formation of the 4th invention is carried out at a substrate and this substrate, and are arranged through a gap, The beam section by which expanding formation is carried out from each [these] leg, and opposite arrangement is carried out through said substrate and gap, The movable piece by which is connected common to the tip side of each [these] ****, and opposite arrangement is carried out through said substrate and gap, The movable electrode formed in the substrate opposed face of this movable piece, and the substrate opposed face of said ****, It has the fixed electrode by which is formed in said substrate and opposite arrangement is carried out through said movable electrode and gap, and said movable piece is taken as a means to solve said technical problem with the configuration which ******s rather than the width of face by the side of the tip of the beam section, and is formed in the broad side.

[0015] The beam section from which the 5th invention constitutes the 4th above-mentioned invention is taken as a means by which the width of face of the beam by the side of a tip solves said technical problem with the configuration currently formed narrowly rather than a end face side.

[0016] The movable piece counterelectrode with which the fixed electrode with which the 6th invention constitutes the 4th or 5th above-mentioned invention counters the substrate opposed face of a movable piece, Separation formation is carried out at the **** counterelectrode which counters the substrate opposed face of the beam section, and the above-mentioned movable piece counterelectrode is accomplished with the detection electrode for detecting the electrostatic capacity between movable electrodes.

The above-mentioned **** counterelectrode is made into a means to solve said technical problem with the drive electrode for bending and making the beam section transform, and the accomplished configuration.

[0017] The movable electrode with which the movable electrode with which the 7th invention constitutes the 4th, 5th, or 6th above-mentioned invention is formed in the substrate opposed face of a movable piece, Separation formation is carried out at the movable electrode formed in the substrate opposed face of the beam section, and the movable electrode of the above-mentioned movable piece is accomplished with the reference electrode for the detection for detecting the electrostatic capacity between fixed electrodes. The movable electrode of said **** is made into a means to solve said technical problem with the reference electrode for the drive for bending and making the beam section transform, and the accomplished configuration.

[0018] In invention of the above-mentioned configuration, the electrical-potential-difference impression means for the movable electrode and fixed electrode of a variable-capacity capacitor being connected to the connection part at which circuits, such as an oscillator circuit and a modulation circuit, were appointed beforehand, respectively, and being included in the above-mentioned circuit, and impressing bias voltage to the above-mentioned movable electrode and a fixed electrode between the movable electrode and fixed electrode is connected. If the bias voltage of a direct current is impressed between the above-mentioned movable electrode and a fixed electrode from the above-mentioned electrical-potential-difference impression means, Coulomb force will act between a movable electrode and a fixed electrode, it will be drawn by the movable electrode to a fixed electrode, the beam section will bend and deform into a substrate side, and a movable piece will displace to a substrate side. With the variation rate by the side of the substrate of this beam section and a movable piece, spacing between a movable electrode and a fixed electrode carries out adjustable, and the electrostatic capacity between a movable electrode and a fixed electrode carries out adjustable.

[0019] In this condition, if a RF signal is impressed between the above-mentioned movable electrode and a fixed electrode from the exterior, the output voltage signal according to the magnitude of the electrostatic capacity between the above-mentioned movable electrode and a fixed electrode will be outputted outside.

[0020] Thus, adjustable [of the electrostatic capacity between a movable electrode and a fixed electrode] is carried out by carrying out adjustable [of the spacing between a movable electrode and a fixed electrode], and since it is possible to perform adjustable control of spacing between the movable electrode and fixed electrode with a sufficient

precision, adjustable control of the electrostatic capacity between a movable electrode and a fixed electrode is performed with a sufficient precision. Moreover, the variable-capacity capacitor of the above-mentioned invention is easy structure, and since it can be manufactured using a surface micro-machining technique, it is easy to attain the miniaturization of a variable-capacity capacitor.

[0021] Since the opposed face product of each **** and a fixed electrode decreases by the tip side rather than the end face side of each **** by having constituted the width of face of each beam section so that a tip side might become narrow rather than a end face side, it originates in reduction of this opposed face product, and it can go across the magnitude of the Coulomb force generated between the movable electrode formed in the substrate opposed face of each ****, and a fixed electrode throughout an opposed face product, and it can be made into homogeneity.

[0022]

[Embodiment of the Invention] Below, the example of an operation gestalt concerning this invention is explained based on a drawing.

[0023] The variable-capacity capacitor of the 1st example of an operation gestalt is shown in (a) of drawing 1 , and the cross-section configuration of the A-A part of the variable-capacity capacitor shown in (a) of above-mentioned drawing 1 is expressed to (b) of drawing 1 . The variable-capacity capacitor of this example of an operation gestalt has a substrate 1, leg 2a and 2b, a doubly-supported beam 3, the drive electrodes 6a and 6b that are **** counterelectrodes, the detection electrode 7 which is a movable piece counterelectrode, the reference electrode 8 which is a movable electrode, and the drawer electrodes 11, 12, 13, and 14, and is constituted.

[0024] As it is indicated in (b) as (a) of drawing 1 , leg 2a and leg 2b are mutually arranged by the substrate 1 through the gap, these leg 2a and 2b are built and opposite arrangement of the doubly-supported beam 3 is carried out through the substrate side and the opening 10. The width of face D of a beam is narrow continuously as this doubly-supported beam 3 goes to a central field from the fixed-end side of both ends. The movable electrode 8 is formed in the substrate opposed face of this doubly-supported beam 3, and the drive electrodes 6a and 6b and the detection electrode 7 by which opposite arrangement is carried out through this reference electrode 8 and opening 10 are formed in the substrate 1.

[0025] Array formation of the above-mentioned drive electrodes 6a and 6b and the detection electrode 7 of each other is carried out in the expanding direction of a doubly-supported beam 3 through the gap, the above-mentioned drive electrode 6a is formed in a leg 2a approach side, drive electrode 6b is formed in a leg 2b approach side,

and opposite arrangement of the detection electrode 7 is carried out to the central field of a doubly-supported beam 3. A fixed electrode is constituted by these drive electrodes 6a and 6b and the detection electrode 7.

[0026] The part of the doubly-supported beam 3 which counters through the above-mentioned drive electrode 6a and an opening 10 constitutes beam section 4a, the part of the doubly-supported beam 3 which counters through drive electrode 6b and an opening 10 constitutes beam section 4b, and the central field of the detection electrode 7 and the doubly-supported beam 3 which counters through an opening 10 constitutes the movable piece 5 from this example of an operation gestalt.

[0027] Moreover, the drawer electrodes 11, 12, 13, and 14 pulled out, respectively from said drive electrode 6a, the detection electrode 7, drive electrode 6b, and a reference electrode 8 are formed in the substrate 1.

[0028] In addition, said substrate 1 is formed with insulator substrates, such as glass and ceramics, a silicon substrate, a gallium arsenide substrate metallurgy group substrate covered with the covering film (for example, a silicon oxide, a silicon nitride, resin), etc. A doubly-supported beam 3 (the beam sections 4a and 4b, movable piece 5) Moreover, a silicon oxide, a silicon nitride, It is formed with silicon etc. and pulls out with the drive electrodes 6a and 6b, the detection electrode 7, and a reference electrode 8. Electrodes 11, 12, 13, and 14 It is formed with semi-conductors, such as silicon which doped impurities, such as metals, such as aluminum, gold, titanium, chromium, silver, copper, palladium, platinum, nickel, and Nichrome, and boron, arsenic, Lynn, antimony.

[0029] The variable-capacity capacitor of this example of an operation gestalt is constituted as mentioned above, and when the variable-capacity capacitor of this example of an operation gestalt is built into an oscillator circuit, a modulation circuit, etc., while said drawer electrodes 12 and 14 are connected to the connection part of the circuit appointed beforehand, respectively, the electrical-potential-difference impression means which is not illustrated will be connected to the drawer electrodes 11, 13, and 14.

[0030] For example, pull out from the above-mentioned electrical-potential-difference impression means, and a current energizes to the drive electrodes 6a and 6b and a reference electrode 8 through electrodes 11, 13, and 14. If the bias voltage of a direct current is impressed between the reference electrodes 8 of the beam section 4a part which counters drive electrode 6a and this drive electrode 6a, and between the reference electrodes 8 of the beam section 4b part which counters drive electrode 6b and this drive electrode 6b Coulomb force acts between the reference electrodes 8 of between the reference electrodes 8 of drive electrode 6a and a beam section 4a part, and a drive electrode 6b and a beam section 4b part.

[0031] this Coulomb force -- the reference electrode 8 of a beam section 4a part -- drive electrode 6a -- and it is drawn by the reference electrode 8 of a beam section 4b part to drive electrode 6b, respectively, and both the beam sections 4a and 4b bend and deform into a substrate 1 side. In connection with the bending deformation by the side of the substrate 1 of these beam sections 4a and 4b, the movable piece 5 displaces to a substrate 1 side, spacing between the reference electrodes 8 of movable piece 5 parts which counter the detection electrode 7 and this detection electrode 7 becomes narrow, and the electrostatic capacity between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts increases.

[0032] On the other hand, if it pulls out from the outside and a RF signal is impressed through an electrode 14 between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts, the output voltage signal according to the magnitude of the electrostatic capacity between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts will pull out, and it will be outputted outside through an electrode 12.

[0033] Thus, this variable-capacity capacitor bends, is made to transform the beam sections 4a and 4b using Coulomb force, can carry out the variation rate of the movable piece 5, can carry out adjustable [of the spacing between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts], and can carry out adjustable [of the electrostatic capacity between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts].

[0034] Below, an example of the manufacture technique of the variable-capacity capacitor of the above-mentioned configuration is briefly explained based on drawing 2 . The cross section of the A-A part shown in drawing 1 is typically expressed with drawing 2 .

[0035] First, the film of the conductor which pulls out with the drive electrodes 6a and 6b and the detection electrode 7, and constitutes electrodes 11, 12, and 13 is formed in the front face of a substrate 1 with membrane formation formation techniques, such as vacuum evaporationo, a spatter, CVD, and printing. the conductor -- the resist pattern which pulls out to the membranous up side with the drive electrodes 6a and 6b and the detection electrode 7, and sets the formation field of electrodes 11, 12, and 13 to it is formed by technique, such as a photolithography. conductors other than the resist pattern part -- etching removal of the film is carried out, after that, as the above-mentioned resist pattern is removed and it is shown in (a) of drawing 2 , it pulls out with the drive electrodes 6a and 6b and the detection electrode 7, and electrodes 11, 12, and 13 are formed in a substrate 1.

[0036] Next, as shown in (b) of drawing 2 , the sacrifice layer (for example, phosphorus glass and the layer of ZnO) 15 is formed in the surface field to which the substrate 1 was defined beforehand by vacuum evaporationo, the spatter, CVD, etc. And the film of the conductor which pulls out with a reference electrode 8 to the substrate 1 up side with which the sacrifice layer 15 was formed, and constitutes an electrode 14 is formed with membrane formation formation techniques, such as vacuum evaporationo, a spatter, CVD, and printing. then, the resist pattern which pulls out with a reference electrode 8 and appoints the formation field of an electrode 14 -- a photolithography etc. -- forming -- excessive conductors the appropriate back and other than the above-mentioned resist pattern part -- etching removal of the film is carried out. this excessive conductor -- after membranous etching removal, the above-mentioned resist pattern is removed, it pulls out with a reference electrode 8, and an electrode 14 is formed.

[0037] furthermore, the conductor -- the leg and the beam building film which forms leg 2a, 2b, and a doubly-supported beam 3 in the membranous bottom are formed, the resist pattern which appoints the formation field of leg 2a, 2b, and a doubly-supported beam 3 at the bottom is formed by a photolithography etc., and etching removal of the excessive leg and beam building film other than the resist pattern part is carried out. And the above-mentioned resist pattern is removed, and as shown in (c) of drawing 2 , leg 2a, 2b, and a doubly-supported beam 3 are formed.

[0038] As etching removal of said sacrifice layer 15 is carried out and it is shown at (d) of drawing 2 , an opening 10 is formed between a substrate 1 and a doubly-supported beam 3 by the last, and a variable-capacity capacitor is completed at it.

[0039] According to this example of an operation gestalt, prepare leg 2a and 2b in a substrate 1, build these leg 2a and 2b, and a doubly-supported beam 3 is formed. Since minded [of this doubly-supported beam 3 / substrate] the reference electrode 8, the opening 10 was minded [this / 8], the drive electrodes 6a and 6b and the detection electrode 7 which carry out opposite arrangement were prepared in the substrate 1, respectively and the variable-capacity capacitor was constituted The structure is easy and it is easy to attain the miniaturization of a variable-capacity capacitor moreover, since manufacturing with a surface micro-machining technique is possible.

[0040] Moreover, since separation formation of the fixed electrode was carried out at the drive electrodes 6a and 6b and the detection electrode 7 and opposite arrangement of the drive electrodes 6a and 6b was carried out in this example of an operation gestalt at the beam sections 4a and 4b, respectively It can bend and the beam sections 4a and 4b can be made to transform by making Coulomb force act between the reference electrodes 8 of drive electrode 6a and a beam section 4a part, and between the reference

electrodes 8 of drive electrode 6b and a beam section 4b part.

[0041] In connection with bending deformation of above-mentioned **** 4a and 4b, the movable piece 5 displaces to a substrate side, and there are more amounts of displacement of this movable piece 5 than the bending deformation (variation rate amount) of the beam sections 4a and 4b. In this example of an operation gestalt Since the detection electrode 7 was formed in the field which counters the movable piece 5 with many the amount of displacement Spacing between the detection electrode 7 and the reference electrode 8 of movable piece 5 parts can carry out adjustable [of the electrostatic capacity between the adjustable necropsy outgoing-call pole 7 and the reference electrode 8 of movable piece 5 parts] greatly only by having been slightly bent by the low battery and making the beam sections 4a and 4b transform by it.

[0042] Furthermore, in this example of an operation gestalt, since it constituted like the above so that the width of face of a beam might become narrow continuously as the doubly-supported beam 3 went to the central field from the fixed-end side of both ends, the following effectiveness can be done so.

[0043] As shown in drawing 3 , a doubly-supported beam 3 is missing from a central field from the fixed-end side of both ends. For example, the width of face of a beam [equal] Namely, if bias voltage is impressed between the above-mentioned reference electrode 8, fixed electrode 6a, and 6b and Coulomb force is generated when it is the configuration formed in the shape of a rectangle Although the central field (movable piece 5) of the above-mentioned doubly-supported beam 3 may displace to a substrate 1 side superfluously and the reference electrode 8 of movable piece 5 parts may stick to the detection electrode 7, it is possible to avoid the above-mentioned problem for the following reasons in this example of an operation gestalt.

[0044] When bias voltage is impressed between the reference electrode 8 shown in above-mentioned drawing 3 , drive electrode 6a, and 6b Coulomb force occurs in magnitude F which followed at the bottom type (2) between the reference electrodes 8 of between the reference electrodes 8 of drive electrode 6a and a beam section 4a part, and a drive electrode 6b and a beam section 4b part. According to this Coulomb force The beam sections 4a and 4b of a doubly-supported beam 3 bend and deform into a substrate 1 side, and spacing becomes narrow as the movable piece 5 of a doubly-supported beam 3 displaces to a substrate 1 side inevitably and it goes to a central field from the fixed-end side of a doubly-supported beam 3 between a doubly-supported beam 3 and a substrate 1 in connection with bending deformation of these beam sections 4a and 4b.

[0045]

F=-q -(Vd/d)- S ..... (2)

[0046] However, q shown in an upper type (2) expresses the amount of charges per [which was defined beforehand] unit electrode surface product, Vd expresses the electrical potential difference impressed to inter-electrode, d expresses inter-electrode spacing, and S expresses the electrode opposed face product.

[0047] When q, Vd, and S which are shown in an upper type (2) are applied to a central field from the fixed-end side of a doubly-supported beam 3, and are in an equal condition, it bends and the beam sections 4a and 4b are made to transform with the configuration shown in drawing 3 Since spacing becomes narrow like the above as it goes to a central field from the fixed-end side of a doubly-supported beam 3 between a doubly-supported beam 3 and a substrate 1, in each opposite field of beam section 4a of a doubly-supported beam 3, 4b parts, and the drive electrodes 6a and 6b, spacing by the side of a tip becomes narrow rather than a end face side. for this reason, in each opposite field of beam section 4a of a doubly-supported beam 3, 4b parts, and the drive electrodes 6a and 6b, rather than a end face side, the Coulomb force which acts between the reference electrode 8 of beam section 4a of a doubly-supported beam 3 and 4b parts and the drive electrodes 6a and 6b will be markedly boiled by the tip side, and will become large, and the movable piece 5 of a doubly-supported beam 3 will displace it to a substrate 1 side superfluously.

[0048] It follows, for example, bias voltage is impressed between a reference electrode 8, drive electrode 6a, and 6b, only by having bent slightly and making the beam sections 4a and 4b of a doubly-supported beam 3 transform, the movable piece 5 of a doubly-supported beam 3 displaces to a substrate 1 side superfluously, and there is a possibility that the reference electrode 8 of movable piece 5 parts may stick to the detection electrode 7.

[0049] On the other hand, since the width of face of a beam is narrow like the above in this example of an operation gestalt as a doubly-supported beam 3 goes to a central field from a fixed-end side The opposed face product of the reference electrode 8 of a beam section 4a part, the reference electrode 8 of the opposed face product of drive electrode 6a and a beam section 4b part, and drive electrode 6b becomes narrow as it goes to a central field from the fixed-end side of a doubly-supported beam 3. It originates in reduction of this opposed face product. Between the reference electrode 8 of a beam section 4a part, and drive electrode 6a, The reference electrode 8 of a beam section 4b part, and the magnitude of the Coulomb force generated among drive electrode 6b Between the reference electrode 8 of a beam section 4a part, and drive electrode 6a, It can cross to all the fields of each opposite field between the reference electrode 8 of a

beam section 4b part, and drive electrode 6b, and can be made homogeneity, and the problem that the above-mentioned Coulomb force will act on movable piece 5 parts of a doubly-supported beam 3 superfluously, and the reference electrode 8 of movable piece 5 parts will stick to the detection electrode 7 can be avoided.

[0050] Moreover, adjustable control of spacing between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be performed with a sufficient precision, and the adjustable control with the highly precise electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 is attained.

[0051] Moreover, the movable piece 5 may displace to a substrate 1 side superfluously only by having been slightly bent by the configuration shown in said drawing 3 , and making the beam sections 4a and 4b transform like the above with it, and the reference electrode 8 of movable piece 5 parts may stick to the detection electrode 7. In this case, even if it raises the level of the bias voltage impressed between a reference electrode 8 and the detection electrode 7, since a reference electrode 8 and the detection electrode 7 will be in a short condition, it cannot carry out adjustable [of the electrostatic capacity between a reference electrode 8 and the detection electrode 7] greatly.

[0052] that is, although the control voltage range of the bias voltage which carries out adjustable control of the electrostatic capacity is very narrow and there is a problem that adjustable control of electrostatic capacity is difficult, as mentioned above in this example of an operation gestalt, the movable piece 5 is superfluous -- since the problem of a variation rate is avoidable, it is possible to make large the variable region of the bias voltage which carries out adjustable control of the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7. From this, adjustable control of electrostatic capacity can be made easy and adjustable control of electrostatic capacity can be performed with a sufficient precision.

[0053] Furthermore, the variable-capacity capacitor of this example of an operation gestalt is easy structure, and since it can be formed using a surface micro-machining technique, it is easy to miniaturize.

[0054] Furthermore, since the width of face D of the beam of a doubly-supported beam 3 is narrow as it goes to a central field from the fixed-end side of a doubly-supported beam 3 like the above, the resonance frequency of a doubly-supported beam 3 becomes high rather than the case which a doubly-supported beam 3 shows to drawing 3 where it is equal width like. Thus, if resonance frequency becomes high, it will be widely different from the frequency of an oscillating noise, an oscillating noise stops riding on the output voltage signal of the variable-capacity capacitor which has a frequency

corresponding to the resonance frequency of this doubly-supported beam 3, and the resonance frequency of a doubly-supported beam 3 can raise the SN ratio of the output voltage signal of a variable-capacity capacitor.

[0055] Furthermore, since the movable piece 5 is supported by two or more beam sections of the beam sections 4a and 4b It is possible to cross spacing between the movable piece 5 and a substrate 1 to all the fields of the opposite field of the movable piece 5 and a substrate 1, and to make it homogeneity mostly, and control of spacing between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 is easy. Adjustable control of the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be performed with a sufficient precision.

[0056] Furthermore, although the electric resistance of the energization path of a signal until the RF signal impressed from the outside is outputted outside as an output voltage signal corresponding to the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 becomes large according to the energization path length of that signal, in this example of an operation gestalt, the energization path length of the above-mentioned signal is short, and its electric resistance of an energization path is small. by this, the Q value of an output voltage signal can be boiled markedly, and can be raised. Furthermore, while originating in improvement in the Q value of this output voltage signal and stabilizing the frequency of an output voltage signal, the carrier noise of an output voltage signal can be reduced.

[0057] In addition, although the RF signal was impressed through the drawer electrode 14 between the reference electrode 8 of movable piece 5 parts, and the detection electrode 7, and the output voltage signal corresponding to the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 was pulled out and outputted to the exterior from the electrode 12 in this example of an operation gestalt A RF signal is impressed through the drawer electrode 12 between the reference electrode 8 of movable piece 5 parts, and the detection electrode 7, an output voltage signal is pulled out, and you may make it output to the exterior through an electrode 14.

[0058] Moreover, you may make it gradually and narrow as it is shown in drawing 4 and the width of face of the beam of a doubly-supported beam 3 is gone to the central field from a fixed-end side, although it was continuously and narrow as, as for the doubly-supported beam 3, the width of face of a beam went to the central field from a fixed-end side in the example of this operation gestalt.

[0059] Furthermore, in this example of an operation gestalt, a fixed electrode may

prepare the fixed electrode which carries out opposite arrangement and uses the function of the drive electrodes 6a and 6b and the detection electrode 7 also [reference electrode / 8], although separation formation was carried out at the drive electrodes 6a and 6b and the detection electrode 7.

[0060] In this case, although the Coulomb force into which cross to all the fields of the opposite field of the above-mentioned fixed electrode and a reference electrode 8, and bend and a doubly-supported beam 3 is made to transform will act From it being narrow as the width of face of the beam of a doubly-supported beam 3 goes to a central field from a fixed-end side It becomes narrow as the opposed face product of said fixed electrode and reference electrode 8 goes to a central field from the fixed-end side of a doubly-supported beam 3. It is possible to originate in reduction of the opposed face product of this fixed electrode and a reference electrode 8, to cross said Coulomb force to all the fields of the opposite field of a fixed electrode and a reference electrode 8, and to make it homogeneity, and the problem of superfluous bending deformation of the central field of a doubly-supported beam 3 can be avoided.

[0061] Furthermore, the film of the conductor which constitutes the drive electrodes 6a and 6b etc. in a substrate 1 when manufacturing the above-mentioned variable-capacity capacitor is formed. The film is removed. the conductor -- the resist pattern which sets formation fields, such as the drive electrodes 6a and 6b, to the membranous bottom -- forming -- excessive conductors other than a resist pattern -- Then, although each component of a variable-capacity capacitor was manufactured by the mold overarm-stroke method so that a resist pattern might be removed and it might say that the drive electrodes 6a and 6b etc. are completed For example, the mask pattern which regulates formation fields, such as the drive electrodes 6a and 6b, to a substrate 1 is formed. The film of the conductor which constitutes the drive electrodes 6a and 6b etc. may be formed in the substrate 1 bottom with which the mask pattern was formed, and each component of a variable-capacity capacitor may be manufactured by the templating technique in which remove the above-mentioned mask pattern and the drive electrodes 6a and 6b etc. are completed after that.

[0062] Below, the 2nd example of an operation gestalt is explained. It being characteristic in this example of an operation gestalt is having formed the movable piece 5 connected [drawing 5] common to the tip side of each **** 4a and 4b so that it may be shown in the broad side jutted out from the width of face D by the side of the tip of the beam sections 4a and 4b. The other configuration is the same as that of said 1st example of an operation gestalt, the same sign is given to the same name part as said 1st example of an operation gestalt, and the duplication explanation is omitted.

[0063] In this example of an operation gestalt, the movable piece 5 connected common to the tip side of each **** 4a and 4b is jutted out from the width of face D by the side of the tip of the beam sections 4a and 4b, and is formed in the broad side, and a reference electrode 8 is formed in the substrate opposed face of above-mentioned **** 4a and 4b and the movable piece 5 like said 1st example of an operation gestalt. In the field by which opposite arrangement is carried out at the reference electrode 8 of the movable piece 5 above-mentioned parts, opposite arrangement of the detection electrode 7 is carried out, and opposite arrangement of the drive electrodes 6a and 6b is carried out in the field which counters the reference electrode 8 of beam section 4a and 4b parts.

[0064] The die length of the beam from the end face side (leg side) of each **** 4a and 4b to a tip side is formed so that it may become equal. Moreover, in this way When it bends and the beam sections 4a and 4b are made to transform by making equal the die length of the beam of the beam sections 4a and 4b While the substrate opposed face of the movable piece 5 maintains a substrate 1 and an parallel condition, the variation rate of the movable piece 5 can be carried out, and adjustable control of the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be performed with a sufficient precision.

[0065] Since according to this example of an operation gestalt the same effectiveness as said 1st example of an operation gestalt can be done so and also the movable piece 5 is formed in the broad side, compared with said 1st example of an operation gestalt, the opposed face product of the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be made large. An adjustable setup of the opposed face product of the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be carried out free [size], and desired electrostatic capacity can be easily obtained from this so that the electrostatic capacity which suits the circuit incorporating a variable-capacity capacitor may be obtained.

[0066] Since electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can moreover be enlarged like the above, the voltage level of an output voltage signal can be raised and the SN ratio of an output voltage signal can be raised more.

[0067] In addition, in this example of an operation gestalt, the width of face D of a beam was narrow continuously as the beam sections 4a and 4b went to the tip side from the end face side, but as shown in drawing 6 , width of face of the beam of the beam sections 4a and 4b may be narrowed gradually. Moreover, although the configuration of the movable piece 5 was a rectangle-like, as shown in (a) of drawing 7 , and (b), it may

be a circle configuration and may form a triangle, the polygon more than a pentagon, etc. in configurations other than the shape of a rectangle.

[0068] Below, the 3rd example of an operation gestalt is explained. It being characteristic in this example of an operation gestalt is having considered as the configuration which supports the movable piece 5 in the three or more beam sections 4 (their are the four beam sections 4a, 4b, 4c, and 4d at the example shown in drawing 9 , drawing 10 , or drawing 11), as shown in drawing 9 , drawing 10 , or drawing 11 . The other configuration is the same as that of said each example of an operation gestalt, the same sign is given to the same name part as said each example of an operation gestalt, and the duplication explanation is omitted.

[0069] In this example of an operation gestalt, the three or more legs are mutually formed in a substrate 1 through a gap, expanding formation is carried out towards the center section of the field where the beam section 4 is surrounded by two or more above-mentioned legs from each [these] leg, respectively, and the common movable piece 5 is connected [side / of each / these / **** 4 / tip]. Opposite arrangement of above-mentioned **** 4 and the movable piece 5 is carried out through the substrate 1 and the opening 10. Moreover, each above-mentioned **** 4 is formed so that the die length of the beam from a end face side to a tip side may become equal.

[0070] The reference electrode 8 is formed in the substrate opposed face of each above-mentioned **** 4 and the movable piece 5, and the drive electrode 6 which carries out opposite arrangement through the substrate opposed face and opening 10 of each above-mentioned **** 4, respectively, and the detection electrode 7 which carries out opposite arrangement through the substrate opposed face and opening 10 of the above-mentioned movable piece 5 are formed in the substrate 1. Moreover, the drawer electrode (not shown) pulled out, respectively from each above-mentioned drive electrode 6, the detection electrode 7, and the reference electrode 8 is formed in a substrate 1.

[0071] The variable-capacity capacitor of this example of an operation gestalt is constituted as mentioned above. While building a variable-capacity capacitor into the above-mentioned circuit by connecting the drawer electrode of the drawer electrode and reference electrode 8 of the above-mentioned detection electrode 7 to the connection part beforehand set to circuits, such as an oscillator circuit and a modulation circuit If the drawer electrode of the drawer electrode and reference electrode 8 of each above-mentioned drive electrode 6 is connected to an electrical-potential-difference impression means and the bias voltage of a direct current is impressed from this electrical-potential-difference impression means between the reference electrode 8 of

each **** 4 part, and the drive electrode 6 Coulomb force acts on inter-electrode [these], it is drawn by the reference electrode 8 of each **** 4 part to the drive electrode 6 side, and each **** 4 bends and deforms into a substrate side.

[0072] In connection with bending deformation of each of this **** 4, the movable piece 5 displaces to a substrate side, and spacing between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can carry out adjustable, and can carry out adjustable [of the electrostatic capacity between the reference electrode 8 of movable piece 5 parts, and the detection electrode 7].

[0073] since it was made the configuration which can do so the same effectiveness as said each example of an operation gestalt upwards, and supports the movable piece 5 by the three or more beam sections 4 according to this example of an operation gestalt, blurring of the movable piece 5 resulting from vibration can be boiled markedly, and can be made small. Moreover, when it bends and the beam section 4 is made to transform, the substrate opposed face of the movable piece 5 can be displaced to a substrate side, with a substrate side and an parallel condition maintained, can be crossed to all the fields of the opposite field of the substrate opposed face of the movable piece 5, and a substrate side, and can equalize more spacing between the above-mentioned movable piece 5 and a substrate 1.

[0074] From this, adjustable control of spacing between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be performed now with a more sufficient precision, and the precision of adjustable control of the electrostatic capacity between the reference electrode 8 of movable piece 5 parts and the detection electrode 7 can be raised more.

[0075] In addition, in the example shown in said drawing 9 , drawing 10 , and drawing 11 , although the movable piece 5 was supported in the four beam sections 4, as shown in (a) of drawing 13 , and (b), the movable piece 5 may be supported in the three beam sections 4, and the movable piece 5 may be supported in the five or more beam sections 4.

[0076] Below, the 4th example of an operation gestalt is explained. It being characteristic in this 4th example of an operation gestalt is having carried out separation formation of the reference electrode 8 at the reference electrode 8 (8a, 8b) of beam section 4 (4a, 4b) part, and the reference electrode 8 of movable piece 5 parts (17), as shown in drawing 14 . The other configuration is the same as that of said each example of an operation gestalt, in this example of an operation gestalt, the same sign is given to the same name part as said each example of an operation gestalt, and that duplication explanation is omitted.

[0077] In this example of an operation gestalt, like the above a reference electrode 8 The reference electrode 8 (8a, 8b) of beam section 4 part, Separation formation was carried out at the reference electrode 8 of movable piece 5 parts (17), and opposite arrangement is carried out through the drive electrode 6 and an opening 10, and the reference electrode 8 (8a, 8b) of the **** 4 above-mentioned part made Coulomb force act between the drive electrodes 6, and is accomplished with the reference electrode for the drive for bending and making the beam section 4 transform.

[0078] Opposite arrangement was carried out through the detection electrode 7 and the opening 10, and the reference electrode 8 of the moving-part 5 above-mentioned part (17) is accomplished with the reference electrode for the detection for detecting the electrostatic capacity between the detection electrodes 7. The reference electrode for the above-mentioned drive (8a, 8b) and the reference electrode 17 for detection are formed through the gap, and are in the insulated condition.

[0079] the lead for [which it pulls out, and an electrode is formed in a substrate 1, and the terminal area is prepared in the reference electrode 17 for said detection, and adds a RF signal to the reference electrode 17 for detection from the exterior at this terminal area, or outputs an output voltage signal from the reference electrode 17 for detection] having been pulled out, respectively from the reference electrode for each above-mentioned drive (8a, 8b) -- a conductor is connected.

[0080] The variable-capacity capacitor of this example of an operation gestalt is constituted as mentioned above. By connecting to an electrical-potential-difference impression means each drawer electrode pulled out, respectively from the reference electrode (8a, 8b) and each drive electrode 6 for each above-mentioned drive, and impressing bias voltage between the reference electrode for each above-mentioned drive (8a, 8b), and the drive electrode 6 Coulomb force is made to act between the reference electrode for each drive (8a, 8b), and the drive electrode 6. It bends, the beam section 4 can be made to be able to transform according to this Coulomb force, adjustable [of the spacing between the detection electrode 7 and the reference electrode 17 for detection] can be carried out, and it can carry out adjustable [of the electrostatic capacity between the detection electrode 7 and the reference electrode 17 for detection].

[0081] And for example, the output voltage signal corresponding to the electrostatic capacity between the detection electrode 7 and the reference electrode 17 for detection pulled out from the detection electrode 7 when it pulls out and a RF signal is impressed between the detection electrode 7 and the reference electrode 17 for detection from the exterior through an electrode is outputted outside from the terminal area of the reference electrode 17 for said detection.

[0082] Since according to this example of an operation gestalt the same effectiveness as said each example of an operation gestalt can be done so upwards and separation formation of the reference electrode 8 was carried out at the reference electrode for a drive, and the reference electrode for detection, the output voltage signal corresponding to the bias voltage of the direct current impressed between the reference electrode for a drive (8a, 8b) and the drive electrode 6 and the electrostatic capacity between the detection electrode 7 and the reference electrode 17 for detection is separable. It disappears from this that an output voltage signal is overlapped on the noise of direct-current bias voltage, and much more reduction of the noise of an output voltage signal can be aimed at.

[0083] In addition, this invention is not limited to each above-mentioned example of an operation gestalt, and can take the gestalt of various operations. for example, the insulator substrate which constitutes the beam section 4 and the movable piece 5 from each above-mentioned example of an operation gestalt -- a conductor -- although the film was formed and the reference electrode 8 was constituted, it is good also as a configuration as which above-mentioned **** 4 and the movable piece 5 are formed with a conductor, and the beam section 4 and movable piece 5 the very thing function as a reference electrode 8. Moreover, the beam section 4 and the movable piece 5 carry out the laminating of some, and you may make it form them among various ingredients, such as silicon oxide, a silicon nitride, silicon, aluminum, gold, titanium, and chromium.

[0084] Furthermore, the configurations of the beam section 4 and the movable piece 5 are not limited to each above-mentioned example of an operation gestalt, may be formed in a configuration as shown in drawing 8 or drawing 12 , and can take various configurations.

[0085] Furthermore, although exposure formation was carried out, you may make it the electrode surface of the drive electrode 6, the detection electrode 7, or reference electrode 8 grade form a protective coat in the electrode surface of one or more pieces among these electrodes in each above-mentioned example of an operation gestalt. In this case, an electrode surface can be protected by the above-mentioned protective coat. Furthermore, although the beam section 4 was made to bend and transform in each above-mentioned example of an operation gestalt using Coulomb force, it bends and you may make it transform the beam section 4 using a piezoelectric device, magnetism, etc.

[0086]

[Effect of the Invention] The leg which is formed in a substrate according to this invention, and the beam section by which expanding formation is carried out from each

[these] leg, Since it considered as the configuration which prepares the moving part connected common to the tip side of each [these] ****, forms a movable electrode in the substrate opposed face of each above-mentioned **** and a movable piece, and forms in a substrate the fixed electrode by which opposite arrangement is carried out at each above-mentioned **** and a movable piece By bending and making the beam section transform, spacing between a movable electrode and a fixed electrode can carry out adjustable, and can carry out adjustable [of the electrostatic capacity between the movable electrode and fixed electrode].

[0087] The electric resistance of the output path of a signal until a RF signal is impressed from the exterior between that movable electrode and fixed electrode and the output voltage signal according to the magnitude of the electrostatic capacity between the above-mentioned movable electrode and a fixed electrode is outputted outside is small, and can aim at improvement in the Q value of an output voltage signal by this. Moreover, the carrier noises of an output voltage signal are reducible with improvement in the Q value of this output voltage signal, it is possible to raise the SN ratio of an output voltage signal, and the dependability of the output engine performance of a variable-capacity capacitor can be raised.

[0088] Furthermore, the variable-capacity capacitor of this invention is easy structure, and since manufacturing with a surface micro-machining technique is possible, the miniaturization of a variable-capacity capacitor is easy.

[0089] Furthermore, rather than the end face side of the beam section, since the width of face of the beam of the beam section is constituted so that it may become narrow, a tip side Since the beam section will be missing from a tip side from a end face side, the resonance frequency of the beam section will become high rather than the case where it is equal width and the resonance frequency of the beam section will be further different from the frequency of an oscillating noise widely It becomes impossible for an oscillating noise to ride on the output voltage signal which has a frequency corresponding to the resonance frequency of the beam section, and the SN ratio of an output voltage signal can be raised.

[0090] moreover, in making Coulomb force act between a movable electrode and a fixed electrode, bending, making the beam section transform, carrying out adjustable [of the spacing between a movable electrode and a fixed electrode] and carrying out adjustable [of the electrostatic capacity between a movable electrode and a fixed electrode] By narrowing a tip side, the width of face of a beam rather than the end face side of the beam section as mentioned above It is possible to make a tip side narrower than the end face side of the beam section for the opposed face product which the

movable electrode and fixed electrode of a **** part counter. By reduction of this opposed face product Over the time of making Coulomb force act between the movable electrode of a **** part, and a fixed electrode, magnitude of the above-mentioned Coulomb force can be made into homogeneity to all the fields of the inter-electrode opposite field.

[0091] It is avoidable that the tip side (movable piece) of the beam section displaces superfluously according to the above-mentioned Coulomb force, it sticks to a substrate, and a movable electrode and a fixed electrode will be in a short condition from this. Moreover, since the problem which a movable electrode sticks to a fixed electrode is avoidable as mentioned above, the adjustable range of the bias voltage level for carrying out adjustable control of the electrostatic capacity between a movable electrode and a fixed electrode is expandable, adjustable control of electrostatic capacity becomes easy, and also precision can improve electrostatic capacity more adjustable control.

[0092] If it is in the thing which a movable piece juts out rather than the width of face by the side of the tip of the beam section and by which it is formed in the broad side While it is avoidable that the tip side (movable piece) of the beam section displaces superfluously according to Coulomb force, it sticks to a substrate, and a movable electrode and a fixed electrode will be in a short condition The opposed face product which the movable electrode and fixed electrode of a movable piece part counter is expandable, by this, an adjustable setup of the opposed face product of the movable electrode and fixed electrode of a movable piece part can be carried out free [size], and it becomes easy to obtain the electrostatic capacity of the request which is adapted for the circuit incorporating a variable-capacity capacitor.

[0093] Moreover, since electrostatic capacity between the movable electrode of a movable piece part and a fixed electrode can be enlarged by the opposed face product of the movable electrode and fixed electrode of a movable piece part being expandable like the above and the voltage level of an output voltage signal can be raised, the SN ratio of an output voltage signal can be raised further.

[0094] If it is at some which carried out separation formation at the movable electrode of a movable piece part, and the movable electrode of a **** part about what carried out separation formation of the fixed electrode at the movable piece counterelectrode and the **** counterelectrode, and a movable electrode When making Coulomb force act between a movable electrode and a fixed electrode, bending and making the beam section transform A detection electrode will exist in the field which there are and counters this movable piece part rather than the bending deformation (variation rate amount) of the beam section, it was slightly bent by the low battery and the amount of

displacement of a movable piece was made to only transform the beam section by it. [many] Spacing between a detection electrode and the reference electrode of a movable piece part can carry out adjustable greatly, and can carry out adjustable [of the electrostatic capacity between a detection electrode and the reference electrode of a movable piece part] greatly.

[0095] If it is in some which carried out separation formation of the fixed electrode at the movable piece counterelectrode and the **** counterelectrode, and carried out separation formation of the movable electrode at the movable electrode of a movable piece part, and the movable electrode of a **** part The bias voltage applied to a variable-capacity capacitor in order to bend and to make the beam section transform, It can prevent that the output voltage signals corresponding to the magnitude of electrostatic capacity do not overlap, and the noise of the above-mentioned bias voltage is overlapped on an output voltage signal, and the SN ratio of an output voltage signal can be raised further.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the explanatory view showing the variable-capacity capacitor of the 1st example of an operation gestalt.

[Drawing 2] It is the explanatory view showing an example of the manufacture technique of the variable-capacity capacitor of drawing 1 .

[Drawing 3] It is the explanatory view showing an example of an equal-width

doubly-supported beam.

[Drawing 4] It is the explanatory view showing the example of a configuration of others of the beam section.

[Drawing 5] It is the explanatory view showing the variable-capacity capacitor of the 2nd example of an operation gestalt.

[Drawing 6] It is the explanatory view showing the other examples of a configuration in the pan of the beam section.

[Drawing 7] It is the explanatory view showing the example of a configuration of others of a movable piece.

[Drawing 8] It is the explanatory view showing the other examples of a configuration in the pan of a movable piece.

[Drawing 9] It is the explanatory view showing the 3rd example of an operation gestalt.

[Drawing 10] The beam section is the explanatory view showing the example of an operation gestalt of a variable-capacity capacitor established four.

[Drawing 11] It is the explanatory view showing the example of an operation gestalt of the variable-capacity capacitor by which the four beam sections were prepared furthermore.

[Drawing 12] It is the explanatory view showing the example of a configuration of others of the beam section and a movable piece.

[Drawing 13] The beam section is the explanatory view showing the example of an operation gestalt of a variable-capacity capacitor established three.

[Drawing 14] It is the explanatory view showing the 4th example of an operation gestalt.

[Description of Notations]

1 Substrate

2a, 2b Leg

4, 4a, 4b, 4c, 4d Beam section

5 Movable Piece

6, 6a, 6b, 6c, 6d Drive electrode

7 Detection Electrode

8, 8a, 8b Reference electrode

17 Reference Electrode for Detection